

Original Communication

# Conditions and circumstances predisposing to death from positional asphyxia in adults

Roger W. Byard MBBS MD (Professor of Pathology)<sup>a,b,\*</sup>,  
Regula Wick MD (Forensic Pathologist)<sup>b</sup>,  
John D. Gilbert FRCPA (Forensic Pathologist)<sup>b</sup>

<sup>a</sup> *Discipline of Pathology, Level 3 Medical School North Building, The University of Adelaide, Frome Road, Adelaide 5005, Australia*

<sup>b</sup> *Forensic Science SA, Adelaide, Australia*

Received 13 July 2007; received in revised form 22 December 2007; accepted 5 January 2008

Available online 10 March 2008

## Abstract

Positional asphyxia refers to a situation where there is compromise of respiration because of splinting of the chest and/or diaphragm preventing normal respiratory excursion, or occlusion of the upper airway due to abnormal positioning of the body. Examination of autopsy files at Forensic Science SA revealed instances where positional asphyxia resulted from inadvertent positioning that compromised respiration due to intoxication, multiple sclerosis, epilepsy, Parkinson disease, Steele–Richardson–Olszewski syndrome, Lafora disease and quadriplegia. While the manner of death was accidental in most cases, in one instance suicide could not be ruled out. We would not exclude the possibility of individuals with significant cardiac disease succumbing to positional asphyxia, as cardiac disease may be either unrelated to the terminal episode or, alternatively, may result in collapse predisposing to positional asphyxia. Victims of positional asphyxia do not extricate themselves from dangerous situations due to impairment of cognitive responses and coordination resulting from intoxication, sedation, neurological diseases, loss of consciousness, physical impairment or physical restraints.

© 2008 Elsevier Ltd and FFLM. All rights reserved.

**Keywords:** Positional asphyxia; Neurological disease; Intoxication

## 1. Introduction

Positional or postural asphyxia refers to a situation where respiration is impeded by the position of a victim's body. This may have a variety of mechanisms including wedging of the body in a confined space preventing movement of the chest wall and diaphragm, or acute flexion of the neck occluding the upper airway. Positional asphyxia differs from crush asphyxia in that the body is not significantly compressed by another object such as a large weight in a motor vehicle roll-over, or by materials such as sand in a trench

cave-in.<sup>1,2</sup> Cases of positional asphyxia also do not involve suspension by the head or neck as in hanging. The following study was undertaken to determine the range of conditions and situations that may predispose to lethal positional asphyxia in adults. It was not designed to be an epidemiological study, but was focused instead on the actual circumstances that predispose to lethal positional asphyxia.

## 2. Materials and methods

A retrospective study was undertaken of the autopsy files from Forensic Science South Australia (FSSA), Adelaide, over an 18-year period from January 1989 to December 2006 for cases of death attributed to positional asphyxia. FSSA provides autopsy services to the State Coroner for the state of South Australia, Australia. South Australia has a population of approximately 1.5 million

\* Corresponding author. Address: Discipline of Pathology, Level 3 Medical School North Building, The University of Adelaide, Frome Road, Adelaide 5005, Australia. Tel.: +61 8 8303 5441; fax: +61 8 8303 4408.

E-mail address: [byard.roger@sauqov.sa.qov.au](mailto:byard.roger@sauqov.sa.qov.au) (R.W. Byard).

people. Over 90% of the state’s coronial autopsies were performed at the Centre over the time of the study. The autopsy information was evaluated and individual cases were selected where it was considered that a particular disease or situation had predisposed to positional asphyxia. No attempt was made to collate the overall numbers of cases, as there were some differences in coding of causes of death over time, and a number of cases were in the ‘grey zone’ diagnostically; i.e. due to the non-specificity of autopsy findings and the lack of definitive information on the initial position of the body at the scene, the diagnosis of positional asphyxia could only be suggested, but not confirmed. Autopsy data were reviewed.

3. Results

Examples of positional asphyxia were found in each of the following categories.

3.1. Intoxication/sedation

Cases were found where individuals who had been in acutely intoxicated or sedated states had slipped into positions where there was splinting of, or pressure on, the chest preventing adequate respiration, or where acute flexion of the neck, pressing the chin against the upper chest, had compromised patency of the upper airway.

*Case 1:* A 44-year-old man was found collapsed on a floor in a kneeling position with his chest resting on his knees. The body was putrefied. Toxicological evaluation revealed a blood alcohol level of 0.28% and a fatal blood codeine level of 2.3 mgIL. There was a history of substance abuse. There were no significant diseases or injuries present. Although the levels of codeine and alcohol would have been sufficient to cause death, it was considered that the position of the body following collapse/loss of consciousness would have contributed to death by restricting respiratory excursion. Death was, therefore, considered most likely to have been due to a combination of factors involving positional asphyxia and mixed alcohol and drug toxicity.

3.2. Organic disease

Cases were found where positional asphyxia was a complication of underlying organic disease that either prevented an individual from extricating him or herself from a compromised situation, or had prevented maintenance of airway patency.

*Case 2:* A 60-year-old man with limited mobility due to a 25-year history of multiple sclerosis was found lying against a wall with his head forcibly flexed and his chin firmly pressed into his upper chest. His face was intensely congested with scattered petechiae caused by compression of large neck vessels<sup>3</sup> due to sharp angulation of his head. It was considered that he had fallen from his bed and had been unable to extricate himself. Death was attributed to positional asphyxia complicating multiple sclerosis.

*Case 3:* A 49-year-old man with a history of epilepsy was found on a kitchen floor with his head pressed against a cupboard and his neck forcibly flexed, pushing his chin into his upper chest. Toxicological screening revealed non-toxic levels of anticonvulsants and antidepressants. Death was attributed to postural asphyxia possibly complicating epilepsy.

*Case 4:* An 86-year-old woman with Parkinson disease and Steele–Richardson–Olszewski syndrome (progressive supranuclear palsy) was found dead in her wheelchair with her head flexed forward. The deceased had required constant use of a neck brace to maintain her airway patency, but this had been removed and was found at her feet. Toxicological evaluation was not significant. Death was attributed to positional asphyxia complicating Parkinson disease and Steele–Richardson–Olszewski syndrome.

*Case 5:* A 23-year-old man with Lafora disease (a progressive degenerative neurological disease) and resultant epilepsy was found dead wedged between two chairs at his home address. He had both facial and conjunctival petechiae due to angulation of his head with vessel compression, and there had been aspiration of gastric contents. Death was attributed to positional asphyxia complicating Lafora disease (the details of this case have been published previously).<sup>4</sup>

3.3. Chronic injury/quadruplegia

Cases were occasionally associated with quadruplegia due to previous injuries to the cervical spinal cord.

*Case 6:* A 36-year-old man who had a previous traumatic cervical spine fracture with resultant quadruplegia was found deceased at his home address with his head slumped forward compromising airway patency. At autopsy there was intense congestion of the face with petechial haemorrhages. Death was attributed to postural asphyxia complicating quadruplegia.

Conditions and circumstances that may predispose to positional asphyxia are summarised in Table 1. Reasons for failure of victims to self-extricate are listed in Table 2.

Table 1  
Conditions and circumstances predisposing to positional asphyxia in adults

Intoxication/sedation
Accidents
Organic diseases
Chronic injury/quadruplegia
Combinations of the above

Table 2  
Reasons for a victim’s failure to self-extricate

Intoxication
Neurological impairment/disease
Loss of consciousness
Physical impairment
Physical restraint
Combinations of the above

#### 4. Discussion

Positional asphyxia refers to circumstances where there is impaired oxygenation because of the position/posture of the body. Essentially it refers to two situations, either where there is mechanical splinting of the chest wall and diaphragm so that entry of air into the lungs is impeded, or where there has been acute flexion of the neck with compromise of airway luminal patency. As noted, situations where there is crushing of the body by a weight, such as a car that has slipped off a jack and compressed the victim underneath, are not included under the category of positional asphyxia, although this distinction is sometimes blurred.<sup>5</sup> On other occasions both crush and positional asphyxia play a combined role in death.

Bell et al. have provided criteria for making the diagnosis of positional asphyxia and these include:

- (1) Finding of the victim in a position that does not allow for adequate respiration. This includes restrictive or confining positions; flexion of the head on to the chest; partial or complete external airway obstruction and neck compression.
- (2) No evidence to implicate another person in the event, with scene examination and history review indicating the victim was responsible for inadvertently placing him or herself in the situation.
- (3) Inability of the victim to extricate him or herself from the situation; e.g. due to intoxication or dementia.
- (4) No evidence of internal airway obstruction from, for example, aspirated food.
- (5) No evidence of carbon monoxide or other suffocating gas inhalation.
- (6) No evidence of significant cardiac disease.<sup>6</sup>

While this certainly clearly defines cases where positional asphyxia has been responsible for death, it does not recognise that positional asphyxia may arise in individuals who have collapsed from underlying organic conditions such as cardiac disease. Padosch et al. also require that there is no evidence of relevant pre-existing cardiac and/or respiratory disease, however, they comment that 'other causes of death, natural and unnatural must be excluded with a reasonable degree of certainty by autopsy'.<sup>7</sup> We would prefer to acknowledge the possibility that natural diseases may contribute to mechanisms of death and to replace Point 6 with:

'There may certain cases where underlying organic illness, such as cardiovascular or respiratory disease is present that may be either unrelated to the terminal episode or, alternatively, may have predisposed to positional asphyxia'.

In analysing cases of positional asphyxia it is apparent that there are two peaks, one in infancy and early childhood, usually associated with accidental deaths from unsafe sleeping situations, and a second that occurs in later

life. Infants and the young are particularly vulnerable to slipping between mattresses and walls, or through defects in broken or defective cots and becoming wedged. Children who have intellectual and physical disabilities are at risk at older ages<sup>8–10</sup> and deaths in adolescents and young adults with severe cerebral palsy have been reported from positional asphyxia related to their bedding arrangements.<sup>11</sup>

In adult life a variety of situations may predispose to positional asphyxia. One that is not infrequently encountered results from intoxication with alcohol, with or without the complication of sedative drugs, as in case 1. In a study of 30 cases of positional asphyxia chronic alcoholism or acute alcohol intoxication was found in 75% of cases with average post-mortem blood alcohol concentrations of 0.24%.<sup>6</sup> Drugs alone may also induce positional asphyxia.<sup>12</sup> Individuals are usually heavily intoxicated and collapse or fall into confined situations where they are unable to breathe properly.<sup>7</sup> This may involve acute flexion at the waist or the neck, suspension upside down, or a position where the head and shoulders are situated below the rest of the body, for example if an unconscious individual has partly slipped from a bed. Knight describes two cases of intoxicated individuals being trapped while attempting to climb through windows in a 'jack-knife' position.<sup>13</sup> In situations where the head has been dependent there may be intense congestion of the face with facial and conjunctival petechiae, although the findings at autopsy in positional asphyxia are often quite non-specific. A Japanese study using rabbits concluded that death in the head down position was due to postural asphyxia, but that survival for half a day was possible in this position.<sup>14</sup>

Postural asphyxia has been reported in cases of accidental death due to sexual asphyxia where individuals have been using anoxia to enhance sexual activity and have forced themselves into rubbish tins or wrapped themselves tightly in plastic. Restriction of respiratory excursion, so necessary to their activities, becomes a fatal liability once they are unable to extricate themselves from the dangerously confined situation.<sup>15–17</sup>

Crucifixion has a component of postural asphyxia when the victim tires and slumps downwards and inspiratory effort requires lifting of the body.<sup>18</sup> This is particularly the case in crucifixion upside down, as the weight of the abdominal viscera compress the diaphragm and the lungs. Additional factors contributing to death in this circumstance are dehydration and hypovolaemia from scourging. During Roman times supervising soldiers were unable to leave the site until death had occurred, so amongst other techniques to accelerate the demise of the victim occasionally a fire would be lit at the base of the cross to exacerbate hypoxia,<sup>19</sup> thus compounding the effects of postural asphyxia.

Organic illness may predispose to positional asphyxia in a variety of ways. Collapse from any condition with loss of consciousness may result in an individual being wedged into a space where breathing is impaired, or where the head is flexed, thus impeding airflow in the oropharynx and trachea. Under these circumstances the underlying organic

disease may not be lethal on its own, but the addition of positional asphyxia results in a fatal outcome. Epilepsy could fall into this category. Alternatively, neurological conditions such as multiple sclerosis in case 2 may result in entrapment following a fall without loss of consciousness. The victim is aware of his/her predicament, but is unable to extricate him/herself due to weakness or paralysis from the underlying disease.

The manner of death in the majority of cases is accidental, however, the possibility of suicide must be considered. In case 4 an 86-year-old woman with Parkinson disease and Steele–Richardson–Olszewski syndrome was found dead in her wheelchair having removed a neck brace that was required to maintain her airway patency. Once the collar had been taken off, acute flexion of the neck occurred due to the inability of weakened neck muscles to maintain a normal posture. While there was no evidence of the involvement of another person in removal of the collar, it remains unclear whether this result was accidental, or had been a suicidal gesture in an elderly individual with severe, progressive and debilitating disease.

Progressive neurological disease may also occur in young adults resulting in muscle weakness, mental impairment and epilepsy. This situation was demonstrated in case 5 with a 23-year-old male with Lafora disease, a rare form of autosomal recessive progressive myoclonic epilepsy that is characterised by grand mal seizures, myoclonic jerking, difficulties with voluntary movements, ataxia and progressive dementia.<sup>3</sup> This constellation of characteristics puts sufferers at risk of positional asphyxia.

Individuals with poor head control for whatever reason, including quadriplegia as in case 6, may also be at risk of positional asphyxia if they are left in a situation where their head can tip forward causing marked neck flexion and airway compromise. Demented individuals in wheelchairs who have slipped down in their restraining jackets may also accidentally asphyxiate.<sup>6</sup>

Although sudden death is a well-recognised, albeit rare occurrence during restraint, the precise mechanism of death has been debated. Initially it was considered that individuals who were hog-tied with wrists and ankles shackled behind them in a prone position were at risk of fatal positional asphyxia due to interference with chest wall and abdominal movements necessary to maintain adequate breathing and oxygenation.<sup>20</sup> Subsequent studies, however, have failed to demonstrate clinically significant alterations to ventilation or oxygenation in normal subjects placed in this position, despite the development of a restrictive pulmonary function pattern.<sup>21</sup> It was argued that the deaths in such cases depended instead on a complex interplay of factors involving so-called ‘excited delirium’, rather than on simple asphyxiation. Individuals who die under such circumstances are often agitated from the combined effects of drug intoxication and psychiatric illness.<sup>22</sup> There may have been injury and the situation is usually stressful as the victim has often been involved in a violent confrontation with others before being restrained by police. High cir-

Table 3

## An autopsy approach to the evaluation of possible positional asphyxia

## Careful scene examination assessing particularly:

- The position of the body and the head
- Evidence of trauma

## Review of the medical history for:

- Diseases that may predispose to positional asphyxia
- The physical ability of the victim to self-extricate
- Drug and/or alcohol use/abuse

## Autopsy examination looking particularly for:

- Lividity and patterns of pressure blanching
- Facial and conjunctival congestion and petechiae
- Trauma
- Significant contributory/non-contributory organic diseases

## Toxicological assessment for:

- Incapacitating levels of ethanol or drugs

culating levels of adrenalin may also predispose to ventricular tachyarrhythmias.<sup>23</sup> The victim is often overweight and unfit, and there is a possibility of adverse reactions of drugs such as cocaine in individuals with abnormalities of cardiac HERG gene ion channels.<sup>24</sup>

Cases of possible positional asphyxia require careful evaluation of the scene with photographs to document the position of the body, and particularly of the head. A full medical history is required to document conditions that may predispose to positional asphyxia and to get an indication of the ability of the victim to extricate him or herself from the position found. Any history of drug or alcohol use/abuse should be obtained. At autopsy, documentation of patterns of lividity and areas of pressure blanching may provide additional weight to the diagnosis, and evidence of facial congestion with facial and conjunctival petechiae should be sought. Any injuries that may implicate another person in the death, or shed light on antemortem accidental trauma, should be evaluated and any underlying organic illnesses that may have caused or contributed to death must also be evaluated in the light of the circumstances (Table 3).

## Acknowledgement

We would like to thank the South Australian State Coroner, Mr. Mark Johns, for permission to report selected details of these cases.

## References

1. Byard RW, Wick R, Simpson E, Gilbert JD. The pathological features and circumstances of death of lethal crush/traumatic asphyxia in adults – a twenty-five year study. *Forensic Sci Int* 2006;**159**:200–5.
2. Byard RW. The brassiere ‘sign’ – a distinctive marker in crush asphyxia. *J Clin Forensic Med* 2005;**12**:316–9.
3. Byard RW, Cains G. Lethal asphyxia – pathology and problems. *Min Minerv* in press.
4. Wick R, Byard RW. Mechanism of unexpected and/or sudden death in Lafora disease. *Forensic Sci Int* 2006;**159**:1444–7.
5. Belviso M, De Donno A, Vitale L, Introna F. Positional asphyxia: reflection on 2 cases. *Am J Forensic Med Pathol* 2003;**24**:292–7.
6. Bell MD, Rao VJ, Wetli CV, Rodriguez RN. Positional asphyxiation in adults. A series of 30 cases from the Dade and Broward County

- Florida Medical Examiner Offices from 1982 to 1990. *Am J Forensic Med Pathol* 1992;**13**:101–7.
7. Padosch SA, Schmidt PH, Kroner LU, Madea B. Death due to positional asphyxia under severe alcoholisation: pathophysiologic and forensic considerations. *Forensic Sci Int* 2005;**149**:67–73.
  8. Amanuel B, Byard RW. Accidental asphyxia in bed in severely disabled children. *J Paediatr Child Health* 2000;**3**:66–8.
  9. Byard RW, Beal S, Bourne AJ. Potentially dangerous sleeping environments and accidental asphyxia in infancy and early childhood. *Arch Dis Child* 1994;**71**:497–500.
  10. Byard RW. Accidental childhood death and the role of the pathologist. *Pediatr Develop Pathol* 2000;**3**:405–18.
  11. Brogan T, Fligner CL, McLaughlin JF, Feldman KW, Kiesel EL. Positional asphyxia in individuals with severe cerebral palsy. *Dev Med Child Neurol* 1992;**34**:169–73.
  12. Malik A, Ravasia S. Positional asphyxia from paroxitine. *Am J Psychiatr* 2005;**162**:125–6.
  13. Saukko P, Knight B. Suffocation and ‘asphyxia’ *Knight’s forensic pathology*. 3rd ed. London: Arnold; 2004. p. 352–67 [chapter 14].
  14. Uchigasaki S, Takahashi H, Suzuki T. An experimental study of death in a reverse suspension. *Am J Forensic Med Pathol* 1999;**20**:116–9.
  15. Janssen W, Koops E, Anders S, Kuhn S, Puschel K. Forensic aspects of 40 accidental autoerotic deaths in Northern Germany. *Forensic Sci Int* 2005;**147**:S61–4.
  16. Byard RW, Hucker SJ, Hazelwood RR. A comparison of typical death scene features in cases of fatal male and female autoerotic asphyxia with a review of the literature. *Forensic Sci Int* 1990;**48**:113–21.
  17. Byard RW, Bramwell NH. Autoerotic death. A definition. *Am J Forensic Med Pathol* 1991;**12**:74–6.
  18. Edwards WD, Gabel WJ, Hosmer FE. On the physical death of Jesus Christ. *JAMA* 1986;**255**:1455–63.
  19. Retief FP, Cilliers L. The history and pathology of crucifixion. *S Afr Med J* 2003;**93**:938–41.
  20. Reay DT, Fligner CL, Stilwell AD, Arnold J. Positional asphyxia during law enforcement transport. *Am J Forensic Med Pathol* 1992;**13**:90–7.
  21. Chan TC, Vilke GM, Neumann T, Clausen JL. Restraint position and positional asphyxia. *Ann Emerg Med* 1997;**5**:578–86.
  22. Chan TC, Vilke GM, Neuman T. Reexamination of custody restraint position and positional asphyxia. *Am J Forensic Med Pathol* 1998;**19**:201–5.
  23. Farnham FR, Kennedy HG. Acute excited states and sudden death. *But Med J* 1997;**315**:1107–8.
  24. Glatzer K, Karch SB. Positional asphyxia: inadequate oxygen, or inadequate theory? *Forensic Sci Int* 2004;**141**:201–2.